Improvement of dietary oil consumption following a community trial in a developing country: The role of translational research in health promotion

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Original Article

Abstract

BACKGROUND: This study aimed to determine the effects of the interventions of Isfahan Healthy Heart Program (IHHP) on the type of oil consumed at the population level. It also tried to assess how this strategy has been effective as a health policy.

METHODS: The IHHP, a six-year community intervention program (2001-07), aimed at health promotion through the modification of cardiovascular disease risk factors. It was performed in Isfahan and Najafabad counties (intervention area) and Arak county (reference area), all in central Iran. This study targeted the whole population of over 2,000,000 in the intervention area. The findings of annual independent sample surveys were compared with the reference area. Dietary interventions were performed as educational, environmental, and/or legislative strategies.

RESULTS: From 2001 to 2007, the mean of changes for hydrogenated oil consumption was -3.2 and -3.6, and for liquid oil it was 3.6 and 2.8 times per week in the intervention and reference areas, respectively ($P < 0.001$). According to Commerce office record, the increase in liquid oil distribution during 2000-2007 was significantly higher in Isfahan than Arak (34% vs. 25%).

CONCLUSION: The effects of the simple, comprehensive, and integrated action-oriented interventions of our program could influence policy making and its results at the community level. It can be adopted by other developing countries.

Keywords: Oil Consumption, Hydrogenated Oil, Liquid Oil, Community Trial

Introduction

The prevalence of noncommunicable diseases (NCDs) has been rapidly increasing worldwide. Their related mortality has been estimated to increase by 15% globally between 2010 and 2020 (to 44 million deaths).[1] Cardiovascular diseases (CVDs) are currently considered as major NCDs causing mortality and morbidity in most countries. They are a great concern in low- and middle-income countries which will face an epidemic of NCDs in the near future. Population-based interventions might reduce the burden of NCDs and their risk factors.[2]

Healthy lifestyle habits are recommended both in health and disease conditions to prevent further diseases. Healthy nutrition for improvement of lipid profile is an integral part of all interventions to prevent or reduce CVD risk at individual or population levels.[2] The quality of the fat consumed in each population is one of the most important nutritional elements that affects cardiovascular

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health. Unlike other dietary fats, trans fatty acids are not essential and have potential health hazards. Most of the trans fat is artificially created in a process known as hydrogenation. Trans fats from partially hydrogenated oils are more harmful than naturally occurring oils.[3] Besides their health hazards to the cardiovascular system and malignancies, there is evidence to suggest that consumption of trans fats can trigger insulin resistance and boost the risk of developing type 2 diabetes. Trans fats not only increase total and low density lipoprotein (LDL) cholesterols, triglycerides, and saturated fatty acids, but also decrease high density lipoprotein (HDL) cholesterol levels.[4,5] Large cross-population studies have shown a strong correlation between trans fat intake and mortality.[6-8]

High prevalence of NCDs, particularly CVDs,[9] and their risk factors[10] have been well documented in Iran. Implementation of public health policies for lifestyle modification is hence necessary. In 2003, about 89% of the Iranian population consumed hydrogenated oils while trans fatty acids constituted 59.1% and 51.2% of available hydrogenated oils and margarines, respectively.[11]

Efforts to reduce trans fatty acid consumption have been performed in several countries. In the 1990s for instance, trans fatty acid content of retail foods was decreased in the Netherlands through interventions in food industries.[3] In the US, mandatory disclosure of trans fat content on food labels led to the reduction of trans fat content of foods by production industries. The improvement was mostly based on population knowledge about the hazards of this type of fatty acids.[12]

In response to the increased burden of NCDs in Iran,[13] the Isfahan Healthy Heart Program (IHHP) was implemented as a comprehensive community-based demonstration program with reference area. The IHHP aimed to integrate programs and policies that effectively impact the major determinants of NCDs, mainly through lifestyle change.[14,15] One of the main strategies of this program targeted improvement in oil production and consumption.

Here, we report the main effects of this six-year interventional program on the type of oil consumed by the population living in interventional areas in comparison to the reference population. We also evaluate how this strategy of the program has been translated to a health policy.

Materials and Methods

Design and sampling

The IHHP aimed to improve the knowledge,

attitude, and practice of the population, health professionals, and CVD patients in order to reduce the risk factors of NCDs that share the same risk behaviors.[14-16]

The IHHP was conducted in the central part of Iran, in two neighboring counties (Isfahan and Najafabad) as the intervention area and one county (Arak) as the control area. According to the national census in 2000, the population was 1895856, 275084, and 668531 in Isfahan, Najafabad and Arak, respectively. Multistage cluster random sampling was used to select eligible individuals from urban and rural areas. Residents older than 19 years of age in these counties were included while pregnant women and mentally retarded subjects were excluded. Written informed consent was obtained from all participants after full explanation of the study. The program was designed in three phases: baseline survey, intervention, and post-intervention phase.

The baseline survey was performed in 2001 in both the intervention and reference areas. It included a total of 12514 participants. The intervention was started in 2002 in Isfahan and Najafabad and lasted until 2006. Annual surveys on independent samples were conducted in both the intervention and reference areas. In baseline and final survey, sampling was performed according to age and sex distribution. Sampling method of Countrywide Integrated Noncommunicable Disease Intervention (CINDI) was used in other annual surveys in both the intervention and reference areas.[14] While routine national health activities continued in the intervention and reference areas, the IHHP interventions aimed at improving four major lifestyle behaviors including tobacco control, healthy diet, physical activity, and stress management. In 2007, a final survey was performed on independent random samples from the two communities. Overall 9570 individuals were studied in the post-intervention survey.

A questionnaire including sociodemographic characteristics and other health-related issues was completed for the participants by trained health professionals.

Dietary assessment

An open-ended food frequency questionnaire (FFQ) was used to assess dietary behavior. This 48-item qualitative questionnaire was adapted from the CINDI program questionnaire.[17] The Persian version of the questionnaire had shown good reliability (r = 0.8) and validity in a previous study.[18] For the present study, the two questions related to

consumption of hydrogenated and non-hydrogenated oils were used. The participants were asked "How many times per week do you consume hydrogenated oil?" and "How many times per week do you consume liquid oil?". The mean number of times these types of oils were consumed in a week was calculated. Additional nutritional status of the intervention vs. reference area were compared in a randomly selected subsample of 1000 adults aging ≥ 19 years old from urban populations in each of the intervention and reference areas. The obtained data was included in the cross-sectional survey. A 24-hour dietary recall questionnaire was used to study the nutritional habits in the subsample. Nutrients contents of the questionnaire were computed by the Iranian Food Consumption Program (IFCP) designed by Isfahan Cardiovascular Research Center (ICRC),[17] based on the Iranian Food Composition Table.[18] Trained nutritionists assisted in fulfillment and rechecking as well as data entry of the assembled dietary questionnaire.

Intervention strategies

Based on the findings from the baseline survey, intervention strategies were designed by considering available human and economic resources. Interventions were conducted through 10 interventional projects with various target groups including youth, women, children and adolescents, worksite staff, health professionals, health volunteers and non-governmental organizations, individuals with CVD risk factors, CVD patients and their family members.[15]

Nutritional interventions were performed through a project entitled "Healthy Food for Healthy Community" (HFHC). This project aimed to improve the knowledge, attitude, and practice of the society regarding healthy nutrition, to increase the availability of healthy nutrition, and to improve the quality of food production and distribution. Details of nutritional interventions have been described previously.[16,19] Only strategies and activities related to hydrogenated/liquid oil consumption are presented here.

Training involved the target groups of all IHHP interventional projects regarding the hazards of hydrogenated oil. It encouraged reduced consumption of fat and substitution of hydrogenated oils with liquid oils. Training sessions were held for owners and staff of restaurants, pizzerias and confectionaries and kitchens of factories, universities, garrisons, and hospitals. Training was supported by formal instructions for serving healthy food choices and healthy cooking in restaurants and fast food shops through reducing oil consumption and using liquid oil. In order to make improvement in oil consumption, collaborations were made with Isfahan Provincial Health Center and food unions to implement approved instructions aimed at reducing the amount of fat and oils in cooking, substituting hydrogenated oil with non-hydrogenated oil, and using modified deep frying oils for frying. Similar instructions were implemented in universities and worksites including offices and factories that served foods.

A monitoring checklist of healthy food choices was designed by ICRC and was integrated into ongoing health system supervising activities to ensure the implementation of the IHHP interventions. Accommodations were made with food industries to produce healthy foods with reduced oil and without hydrogenated oil in order to sustain an initially established partnership between the academic field, industry, and other health-related sectors. This partnership was later transferred and registered as a non-governmental organization named "Food Industry and Healthy Community Association". Its members were from food industries, faculty members specialized in nutrition, medicine, and public health, and other stakeholders such as Provincial Commerce Office, the Food and Drug Supervision Office, Standard and Industrial Research Institution, and researchers and collaborators of HFHC. The association aimed at facilitating the cooperation between food industries and scientific institutes toward manufacturing healthy food products. Moreover, it offered new and healthy formulations for food products and provided facilities to encourage food industries to produce healthy products. The intervention covered products such as oil, margarines, beverages, canned fish, soymilk, sweets, candies, cakes, pies, biscuits, and low-fat dairy products.

At the beginning of the IHHP interventions in 2001, subsidized dietary oil distributed by the Ministry of Commerce was mainly in the form of hydrogenated oil. Therefore, users of liquid oil had to pay some extra money for receiving liquid oil. Collaborations were made with the provincial Commerce Office to substitute hydrogenated oil with liquid oil in 2003. The proposal was reflected to the Nutrition Improvement Department in the Ministry of Health and then to the Ministry of Commerce, responsible for provision and distribution of oil throughout the country. It was later implemented at the national level. Moreover, extensive requested letters were sent to Isfahan

Provincial Commerce Office to increase liquid oil subsidiaries in Isfahan and Najafabad. Correspondences were made with this office to substitute production of hydrogenated oil with liquid oil by the only oil production factory in Isfahan which was approved by Ministry of Commerce. Food industries were asked to add information about trans fatty acids and saturated fat content of oils to the labels on their food products and the community was informed to read these labels.

Statistical analysis

Univariate analysis of variance (ANOVA) was used to compare the mean consumption of hydrogenated and liquid oil per week in intervention and control areas in annual surveys. T-test was used to compare the mean values of weekly consumption of hydrogenated or liquid oil in pre- and post-intervention phases. General linear model was used to compare the trend and the mean changes of hydrogenated oil and liquid oil consumption in intervention and reference areas. SPSS for Windows 15.00 (SPSS Inc., Chicago, Il, USA) was used to analyze the data. P values of less than 0.05 were considered as significant.

Results

Table 1 shows the characteristics of the study population. The baseline survey included a total of 12514 subjects. The annual surveys included 5891, 4793, and 6083 subjects from 2002 to 2004, respectively. Because of financial limitations, the fourth annual evaluation (in 2005) could not be conducted in the reference area and just included 3010 individuals in the intervention area. The final survey in 2007 included 9572 participants. Additional nutritional status was assessed in 1749 and 1632 urban individuals in 2001 and 2007, respectively.

Figure 1 shows the trend of hydrogenated oil consumption in the reference and intervention areas. Throughout the study, the mean frequency of weekly hydrogenated oil consumption was significantly lower in the intervention area than in the reference area. The mean frequency of hydrogenated oil consumption decreased in both reference and intervention areas from 2001 to 2007 but with a greater slope in the intervention area. The mean weekly consumption of liquid oil was significantly higher in the intervention area. In fact, it increased in both areas but with a higher slope in the intervention area ($P < 0.001$) (Figure 2). The mean changes in weekly consumption of hydrogenated oil were -3.2 and -3.6 times in the intervention and reference areas, respectively. During 2001-2007, the mean increase of liquid oil consumption was 3.6 and 2.8 times per week in the intervention and reference areas, respectively ($P < 0.001$).

Table 1. Characteristics of the study population in the reference and intervention areas from 2001 to 2007

|		Baseline survey (2001)	First evaluation (2002)	Second evaluation (2003)	Third evaluation (2004)	Forth evaluation (2005)	Fifth evaluation (2006)
Residency							
Urban	Intervention	4873	2438	1950	2402	2652	3897
	Control	4220	1932	1556	2119		2795
Rural	Intervention	1302	556	450	613	360	822
	Control	2119	965	837	962		2058
Sex							
Male	Intervention	3006	1482	1186	1479	1453	2320
	Control	3117	1416	1183	1492		2458
female	Intervention	3169	1512	1214	1534	1558	2399
	Control	3222	1481	1210	1578		2395
Education (years)							
0-5	Intervention	2738	1316	1040	1649	1454	1641
	Control	3659	1717	1203	1768		2658
6-12	Intervention	2704	1220	1041	1071	1185	2130
	Control	2112	973	927	1001		1862
> 12	Intervention	626	417	299	288	372	931
	Control	451	198	257	301		333
Age (years)*							
	Intervention	6.80 ± 4.36	6.43 ± 4.74	5.69±4.48	3.76 ± 4.36	3.97 ± 4.63	3.04 ± 4.45
	Control	10.63 ± 4.61	10.15 ± 4.93	8.90±4.68	8.62 ± 5.08	-	7.38 ± 5.36

* Mean ± SD
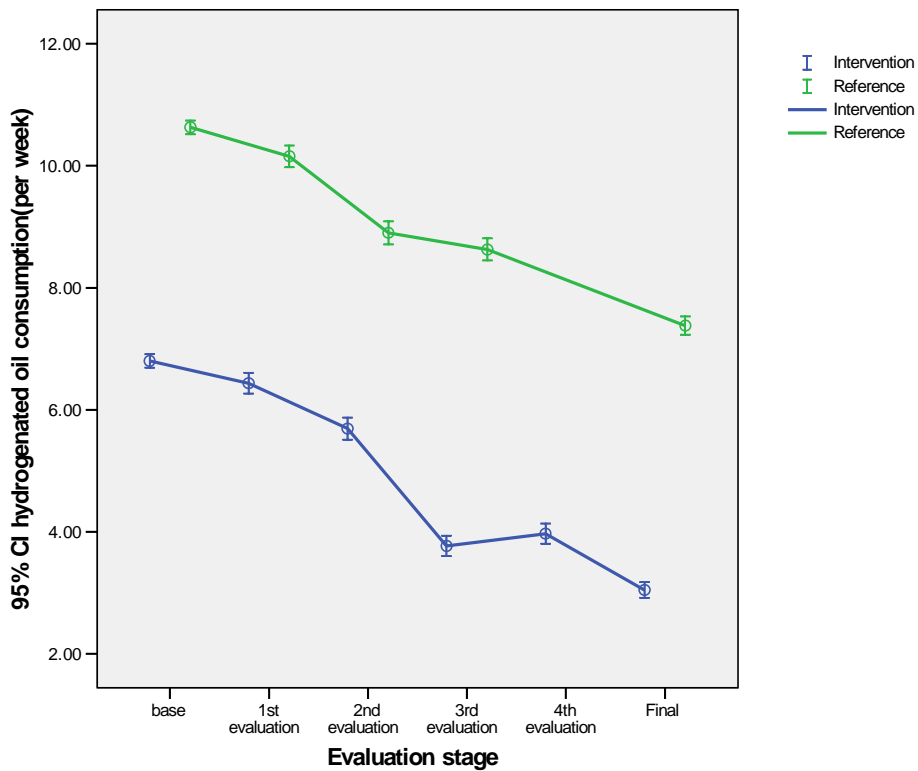
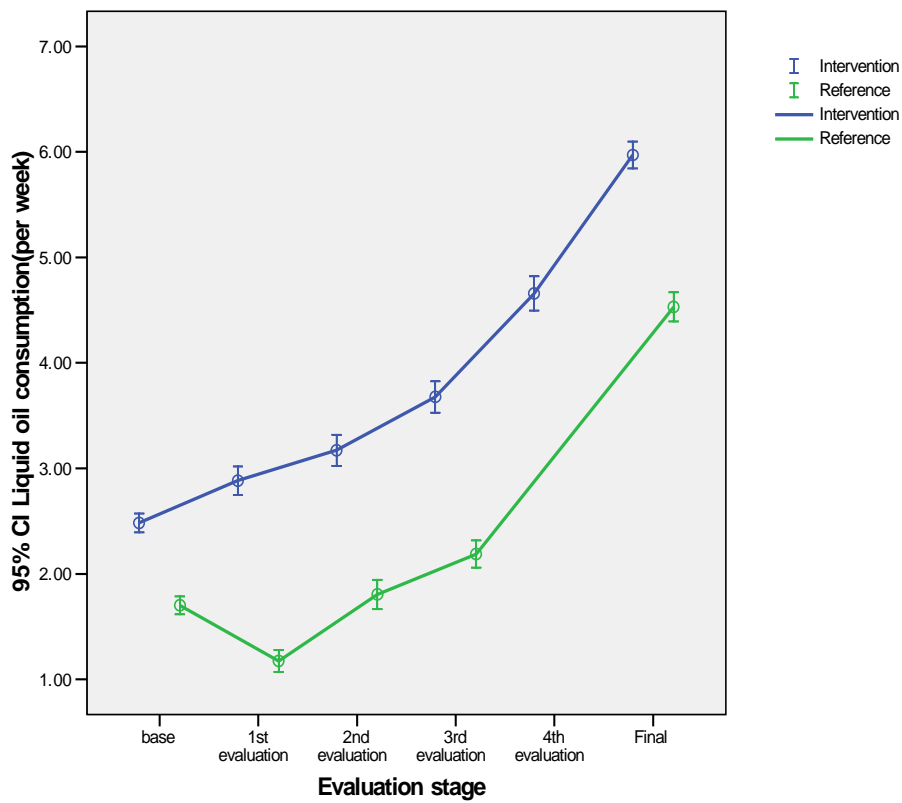**Figure 1.** Trend of hydrogenated oil consumption in the intervention and reference areas

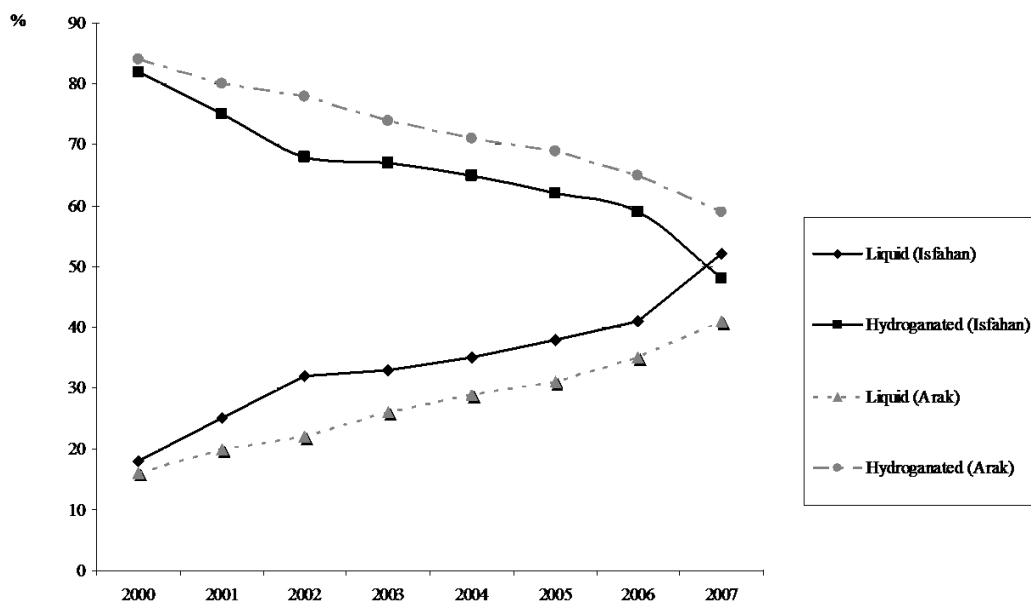**Figure 2.** Trend of liquid oil consumption in the intervention and reference areas

Figure 3. Trend of hydrogenated and liquid oil distribution in intervention and reference area based on Commerce office records

Table 2. The mean changes in dietary fat and oils intake in subsamples of the intervention and reference areas in 2001-07

Oils	Intervention Area			Reference Area			P
	2001	2007	P	2001	2007	P	
Hydrogenated oil (g/day)	15.2 ± 4.3	7.4 ± 3.8	0.005	18.3 ± 4.2	13.4 ± 3.7	0.020	0.030
Liquid oil (g/day)	9.6 ± 3.7	16.7 ± 4.9	0.006	10.5 ± 3.8	12.7 ± 3.9	0.100	0.008

Values are expressed as mean ± SD.

Based on the Commerce Office records, from 2000 to 2007, the distribution of hydrogenated oil was higher in the reference area. On the other hand, distribution of liquid oil was higher in the intervention area. Trend of hydrogenated oil distribution showed a descending slope in both intervention and control areas. Distribution of liquid oil had a rising trend in both areas with a higher slope in the intervention area (P < 0.05, Figure 3).

Liquid oil production increased from 21.5% in 2004 to 56.5% in 2008. Canola oil comprised the greatest share of produced oils. At the end of the intervention, restaurants and food shops increased usage of frying oil to 100%. Restaurants used liquid oil for cooking all foods except rice (15% hydrogenated oil).

Table 2 shows changes of hydrogenated and liquid oils intake in intervention vs. reference areas based on 24-hour recall in 2001-2007. The trend of hydrogenated oil consumption showed significant reduction and liquid oil showed a significant enhancement in intervention area (P = 0.03 and P = 0.008, respectively).

Discussion

To the best of our knowledge, this interventional study was the first of its kind not only in Iran, but also in the east Mediterranean region. It could successfully decrease the consumption of hydrogenated oil and substitute it with liquid oil. Increasing liquid oil distribution in intervention acea has become circulated as a health policy by the Commerce Office. According to independent reports of Commerce Office, the implementation of this policy showed consistent changes in the type of distributed oil. It was confirmed at population level based on the results of IHHP surveys. The hazardous effects of high fat intake have been known for more than five decades. It is well-documented that limiting dietary fat reduces cardiovascular mortality.[7] Further studies revealed that diets lower in trans fat and higher in unsaturated fat may particularly decrease the risk of cardiovascular death even among individuals with previous cardiovascular events.[6] All scientific evidence in this field has improved knowledge on the role of diet on health. In addition, better

understanding of dietary elements at molecular level has directed scientific recommendations to focus on diets low in saturated fat. The Global Strategy on Diet, Physical Activity and Health (DPAS) considers diet and physical activity as two main risk factors of NCDs. It hence recommends lower daily fat intake and a shift from saturated fat toward unsaturated fat with the final goal of eliminating trans fatty acids from diet.[20] Latest dietary recommendations advise reduction of trans fatty content of foods to less than 1%.[21]

Various strategies have been implemented in different countries to reduce total, saturated, and trans fat intake. Based on scientific evidence,[22] government support,[23] legislation, ratifying regulations for food industries,[12] enhancement of public knowledge,[24] and using technology in production of new and healthier formulations for fats and oils[3,25] are among these strategies. The IHHP benefited from a variety of action plans and strategies to implement healthy nutrition in the intervention area. It in fact tried to increase public knowledge, improve public attitudes and behaviors, develop new regulations and enforce the existing ones based on collaboration with food industries, and increase the production and distribution of healthier types of oils.

Using an FFQ and a 24-hour recall questionnaire, we observed reduced hydrogenated fat consumption and increased liquid oil consumption after six years of intervention at the community level. This reflects improved public consumption pattern that can be explained in part by enhanced knowledge and practice. The IHHP strategy to improve people's knowledge can also be observed in other dietary habits of the population such as improvements in fat and meat consumption indices reported in a previous study.[16] Although as a reflection of the national policies in increasing the production of liquid oils, favorable changes were also documented in the reference area of our study, the considerably higher levels of improvement in the intervention area are an evidence for the success of the project's interventions.

The role of public knowledge in the amount and type of consumed fat can be proved by reduced consumption of fat and oils in the American diet between 1989 and 1996. The American population seemed to effectively reduce foods classified in the 'oil and fat' category. However, the amount of fat within other food categories, especially meat, was increased.[3] Consumers' awareness on healthy and unhealthy food items will also affect the food

industries that seek consumer satisfaction to keep their sale and reputation.[26,27]

The IHHP enhanced labeling of food products, in particular oils and trans fat content, by encouraging oil production companies to add the level of industrial trans fatty acids on their labels and educating and encouraging people to read labels on food products. In the beginning of IHHP, an evaluation was done to assess the awareness, use and understanding of these labels by the consumers. Only 7% reported that they read the labels regularly, mainly because labels are too complicated and reading them needs longer time. Furthermore, 95% of participants stated that they did not understand the labels. Together with the food producers and based on the consumers' suggestions, IHHP started an initiative to simplify the labels, so that contents only refer to total energy, total fat, saturated fat and trans fatty acids, sugar and salt and to place the labels by the production date to increase consumers attention.[28] The effects on consumers' choice and sensitivity to quality of products might have indirectly reduced the rate of hydrogenated oil consumption. A similar experience was observed in the US where mandatory labeling of industrial trans fat content of food products was enacted in 2006. Primary recommendations had been made in 1994 (about 12 years earlier). Later, the regulations were extended to ban the use of industrial trans fats in restaurants. The chain of improvement, which started from federal regulations in food industry, developed rapidly to other parts of food production industry and supply and even enhanced related research in the field for providing more qualified oils.[12] In 2006, about 96% of packaged foods in the US had nutrition labeling with 12% providing data about the amount of tans fats.[26]

The present report from our study is mainly devoted to reporting one of the outcomes of the IHHP. Educational and intersectoral collaboration between scientific and executive manager of the study influence the policy of a public sector responsible for distributing oil in the community level. This strategy improved the availability of a healthier type of oil. As supported by the World Health Organization's latest scientific update in 2004, modification of public nutritional habits requires the collaboration of many stakeholders in public and private sectors.[22] The completing part, that is the population demand, was affected through various activities aimed at improving people's knowledge about the health hazards of hydrogenated oil and the necessity of substituting it

with liquid oil.

Previous studies have advised the discrimination of percentage versus total fat intake when interpreting trends of dietary components.[24] Therefore, the observed improvement in the trend of hydrogenated and liquid oil intake in Iranian population cannot be counted as a real improvement in oil consumption unless the findings of a previous study from the IHHP data are considered. This study showed an improvement in the kind of oil consumption in the intervention area.[16] In the setting of reduced total fat intake, relative improvement in type of oil is interpreted as a positive change in dietary habits. This seems a possible result of activities and policies that have been implemented in the IHHP. Moreover, reports of Commerce Office, which provides a major source of oil consumption in the community, adds to the validity of our findings. The political will and community request besides our extensive contacts and follow-up with the Office of Nutrition Improvement in the Ministry of Health resulted in a recent legislation that mandates the production of oils with trans fatty acid content less than 15%. An external evaluation by a team of experts from National Institute for Health and Welfare of Finland in 2009 confirmed the benefits of nutritional interventions.[28]

However, as a limitation of our study, improved knowledge of the population might have made them say they had consumed liquid oil than hydrogenated oil. We did not assess intake of other sources of hydrogenated oil. Hence, the findings cannot be generalized unless we know total caloric intake and percentage of all dietary nutrients from the beginning to the end of this intervention.

Conclusion

Community-based interventions can improve healthy lifestyle in the population through establishing partnership between stakeholders, population, and industries. This is practiced through enhancing public knowledge based on scientific findings that sensitize people to shop healthier products. Healthy recommendations help industries keep their credit by elevating the quality of their products. Involving stakeholders and policy makers in such community trials assures the implementation of recommendations. The leading role of research centers can enhance the acceptance of the recommended improvements among authorities and the society. The effects of simple, comprehensive, and integrated action-oriented

interventions of our program are evidences on how research can influence policy decisions at community level.

Conflict of Interests

Authors have no conflict of interests.

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